The 6th International Conference on Construction Engineering and Project Management (ICCEPM 2015)
Oct. 11 (Sun) ~ 14 (Wed) 2015 • Paradise Hotel Busan • Busan, Korea
www.iccepm2015.org

Scenario-based Learning: Experiences from Construction Management Courses

Benson Teck-Heng Lim[1] and Bee Lan Oo[2]

Abstract: ***Scenario-based learning (SBL) has been used in a variety of training situations across different disciplines. Despite its seemly widespread use in construction management discipline, very few attempts have been made to explore its effectiveness and the respective students' learning experience. Using a survey research design, this study aims to investigate students' perceptions on SBL approach in construction management courses. The specific objectives are: (i) to identify the characteristics of a favourable SBL environment, and (ii) to explore the students' learning experience and effectiveness of the SBL approach. The results show that the four characteristics of a favourable SBL environment are: effective team formulation, constant engagement with lecturer, working in a group, and incorporation of motivational incentive for participation. The students really appreciated the opportunities to apply concepts learnt in the lectures in their SBL group work. Also, they perceived that the SBL approach is effective in developing their reflective and critical thinking skills, analytic and problem-solving skills and their ability to work as a team. These findings should facilitate more critical approaches to similar form of teaching methods.***

Keywords: Construction management, learning experience, scenario-based learning

I. INTRODUCTION

According to Savin-Baden [1], scenario-based learning (SBL) is increasing used as a 'catch-all' for a number of active forms of learning including problem-based learning, case studies, project-based learning, problem-solving, simulations, games, and using scenarios in e-learning. Similarly, Coghlan [2] considered SBL as a form of problem-based learning. On the other end, Buch and Wolff [3] classified SBL as a form of enquiry based learning. Kindley [4] argued that SBL is different from simulations and games in which SBL poses situations and requests a particular response, whereas both simulations and games seek to create a whole reality in which the participant is immersed. Despite the different classifications of SBL in the literature, there is a general consensus among authors that SBL is a form of experiential learning or "learning by doing" that emphasize a student centre approach. The key characteristics of SBL include ([5] & [6]): (i) the use of a real context to place students in a realistic situation; (ii) active learning that requires student to draw on the experience, knowledge and skills they acquired from formal class teaching and apply them to a given scenario; and (iii) the role of the educator as a 'facilitator' to guide and support students in their own learning.

SBL has been used effectively in a variety of training situations across different disciplines. For example, more recently, Frost et al. [7] reported the use of SBL to teach communication skills to medical students; Coghlan [2] used SBL to teach tourism management at postgraduate level; and Thomsen et al. [6] introduced SBL to undergraduate electronic and electrical engineering students. The students' feedback on SBL in these studies is positive and encouraging. For construction management discipline, it is noted that various attempts to apply SBL approach have been reported as simulations or game-based learning. This can be partly explained because the scenarios are often illustrated with advanced interactive media, and have a game-like appearance. Deshpande and Huang [8] have identified various simulations and games in civil engineering that focus on construction management practices.

Despite the seemly widespread use of simulations and games in construction management discipline, very few attempts have been made to evaluate the educational simulations and games upon practice, partly because of the lack of useful evaluation frameworks [9]. De Freitas and Oliver [10] argued that the evaluation exercises are important to support more critical approaches to a similar form of teaching methods. Nevertheless, it is encouraging to see a handful of work that found simulations and game-based learning are effective in enhancing student learning in construction management discipline (e.g. [11], [12], [13] & [14]). In addressing this knowledge gap, this study aims to investigate students' perceptions on SBL approach in construction management courses. The specific objectives are: (i) to identify the characteristics of a favourable SBL environment, and (ii) to explore the students' learning experience and effectiveness of the SBL approach. It should be noted that the use of scenarios in the present work was more on provision of a realistic context for completing a reasonably complex group task without using any advanced interactive media. Therefore, the term SBL is used, but not using simulations or game-based learning.

[1] Senior Lecturer, UNSW Australia, Kensington Campus, NSW 2052, Australia, b.lim@unsw,edu,au (*Corresponding Author)
[2] Senior Lecturer, UNSW Australia, Kensington Campus, NSW 2052, Australia, bee.oo@unsw.edu.au

II. CONTEXT

This paper focuses on SBL in two construction management courses in two Australian universities (Institutes A and B hereafter). The reasons for having students' responses from two different institutes are to increase the representativeness of the sample data, and to detect if there is a significant difference(s) in their perceptions. The courses are on project and facility management subject areas where students were required to complete group work based on different scenarios. Let us illustrate the SBL approach using the project management subject as an example. Firstly, student groups were required to define the project scope, and estimate the schedules and budgets of a real past construction project based on a given set of drawings. During SBL implementation stage, student groups were required to determine the effects of a given scenario on their initial project scope, schedules and budgets, and to revise their work plans, schedules and budgets accordingly. The given scenarios include: (i) a requirement to shorten proposed project schedules in order to meet a new completion date imposed by the client; (ii) a construction delay due to inclement weather; (iii) a union's decision to strike that caused 1-month delay to the work; and (iv) a construction delay due to a site accident. These scenarios simulated 'real-life' situations, and attempted to emphasize: (i) the relationship between project scope, time and cost; (ii) the concept of trade-offs in project management; and (iii) the need for communication and coordination in order to be able to respond effectively to changes in project objectives and constraints. To maximize students' learning in the SBL approach, each student group was assigned with different scenarios and required to make an oral presentation in sharing their solutions to the class. In this way, the class had the opportunities to gain exposures to different scenarios and a variety of solutions.

III. RESEARCH METHOD

This study adopted a survey research design for its abilities to provide a relatively quick and efficient method to (i) obtain information from the targeted sample, and (ii) generalize the research findings based on the sample involved. This design is well-established across many disciplines in obtaining feedback on students' perceptions and learning experience. The students from both institutes were requested to complete a structured questionnaire by rating the measurement items (or statements) based on a seven-point Likert scale, 1 (strongly disagree) to 7 (strongly agree). One-sample *t*-test was applied to the two datasets to test the significance of the students' perceptions about SBL. This was done by comparing the mean scores of the sample to a known value. Here, a test-value of 4 (i.e., the neutral score) was used to evaluate the students' perceptions if they at least moderately agreed (mean score that is statistically greater than 4), and if they moderately disagreed and/or neither agreed or disagreed (mean score that is statistically below 4) for each specific item. Rather than simple averaging, this provides an objective measure in identifying any specific item that calls for attention to address weaknesses in the SBL approach. For comparing the students' perceptions between the two institutes, a two-sample *t*-test was used to test the equality of their means. This test determines any significant differences in the students' perceptions on the measurement items. However, it should be noted that the FDR (Benjamini-Hochberg) correction method using a false discovery rate of 0.05 was applied to both the one-sample and two-sample *t*-tests as they involved testing of multiple items. In this, all of the *p*-values from the *t*-tests that are smaller than the FDR critical value are significant (see [15] for FDR procedures).

IV. RESULTS

There were 60 and 147 students enrolled in the respective courses in Institutes A and B. Of these, the numbers of students responded to the questionnaire are 40 and 135, thus representing response rates of 67% and 92%, respectively. These considerably high response rates enhance the representativeness of the survey findings. Table I shows the results of the one-sample *t*-test for the four items on characteristics of a favourable SBL environment. It can be seen that the mean scores for all the four items are statistically greater than 4 (ranging from 4.900 to 6.150) based on the FDR significance for both institutes. A possible implication of these significant results is that similar attempts to introduce SBL in teaching should consider these four characteristics in their SBL design and implementation. In particular, effective team formulation with highest mean scores from both institutes clearly suggests that the formulation of team with right members would enhance their learning experience in SBL, similar to the findings of Thomsen et al. [6]. It is worth noting that teamwork skills have always been strongly emphasized in simulation and game-based learning [16].

Table II shows the results of the one-sample *t*-test for the items on students' learning experience and effectiveness of the SBL approach. Encouragingly, the results show that the mean scores of all items are statistically greater than 4 based on the FDR significance for both institutes - signifying students' positive responses to the use of SBL approach in the courses. In addition, it is interesting to note that the three top-ranked items based on the mean scores for both institutes are identical. They are items L1, L6 (and L8 for institute A with identical mean scores), and L7. It is clear that the students really appreciated the opportunities to apply concepts learnt in the lectures in their SBL group work (item L1, highest mean scores of 5.975 and 5.674 for Institutes A and B, respectively). Although there is no specific item on the achievement of intended learning outcomes of the courses, these mean scores indicate that the students have managed to learn by testing and applying the ideas and concepts acquired from the formal class teaching. Next, the students' positive perceptions on items L6, L7 and L8 have further demonstrated the importance of collaborative learning and social interaction in SBL, similar to that of

Coghlan [2]. For the remaining items on learning experience (L2, L3, L4, and L5), the students' responses are all positive with mean scores above 5 for both institutes. This means they perceived the SBL approach is effective in developing their reflective and critical thinking skills, analytic and problem-solving skills and their ability to work as a team. In terms of overall satisfaction (item S1), it can be seen that the mean score of Institute A is slightly higher than Institute B (5.650 vs. 5.296). However, this difference is not statistically significant (see Table III).

TABLE I
CHARACTERISTICS OF A FAVOURABLE SCENARIO-BASED LEARNING ENVIRONMENT

Item		Mean		One-sample *t*-test (test value = 4)							
		Inst. A	Inst. B	Inst. A				Inst. B			
				t	*P*-value (2-tailed)	FDR critical value	FDR Sig.	*t*	*P*-value (2-tailed)	FDR critical value	FDR Sig.
C1	Incorporation of motivational incentive into the scenario-based group work would definitely enhance learning	4.900	4.874	4.201	0.000	0.054	Sig.	6.105	0.000	0.054	Sig.
C2	Constant engagement with lecturer is critical in the scenario-based group work	5.850	5.111	11.130	0.000	0.031	Sig.	10.480	0.000	0.042	Sig.
C3	Effective team formulation would definitely enhance the scenario-based learning	6.150	5.622	15.742	0.000	0.004	Sig.	16.948	0.000	0.008	Sig.
C4	Working in a group for scenario-based learning is important	5.125	5.111	4.674	0.000	0.050	Sig.	7.535	0.000	0.050	Sig.

TABLE II
STUDENTS' LEARNING EXPERIENCE AND EFFECTIVENESS OF THE SCENARIO-BASED LEARNING APPROACH

Item		Mean		One-sample *t*-test (test value = 4)							
		Inst. A	Inst. B	Inst. A				Inst. B			
				t	*P*-value (2-tailed)	FDR critical value	FDR Sig.	*t*	*P*-value (2-tailed)	FDR critical value	FDR Sig.
L1	The group work scenarios require me to apply concepts which I have learnt in the lectures	5.975	5.674	15.609	0.000	0.008	Sig.	18.786	0.000	0.004	Sig.
L2	The group work scenarios require me to engage in independent and reflective learning	5.625	5.259	9.134	0.000	0.042	Sig.	13.393	0.000	0.027	Sig.
L3	The group work scenarios have developed or enhanced my analytic and problem-solving skills	5.575	5.126	11.804	0.000	0.019	Sig.	10.190	0.000	0.046	Sig.
L4	The group work scenarios have developed or enhanced my team working ability	5.500	5.333	9.874	0.000	0.035	Sig.	14.642	0.000	0.023	Sig.
L5	The group work scenarios have developed or enhanced my critical thinking ability	5.550	5.178	11.590	0.000	0.023	Sig.	11.751	0.000	0.031	Sig.
L6	The group work scenario requires our group to interact actively for solution development	5.775	5.533	14.626	0.000	0.012	Sig.	16.428	0.000	0.015	Sig.
L7	The group work scenario has given me a valuable insight on the importance of cooperation and tolerance in a teamwork environment	5.875	5.422	13.437	0.000	0.015	Sig.	16.347	0.000	0.019	Sig.
L8	My team members took the group work scenario seriously, diligently completed the task	5.775	5.296	9.819	0.000	0.038	Sig.	10.530	0.000	0.038	Sig.
S1	Overall satisfaction with the scenario-based group work	5.650	5.296	11.327	0.000	0.027	Sig.	16.923	0.000	0.012	Sig.

Table III shows the results of the two-sample *t*-test for all the items. It can be seen that the mean scores of only two (out of thirteen) items are statistically different between the two institutes based on the FDR significance. These are items 'C2 constant engagement with lecturer' and 'C3 effective team formulation' on characteristics of a favourable SBL environment. The mean scores of these two items for Institute A are significantly higher than those for Institute B. For item C2, it can partly be explained by the smaller class size (i.e., 60) of the respective course in Institute A where students would likely to have more opportunity to engage with their lecturer, and thus rated this item higher than those in Institute B. As for item C3, the high mean scores could indicate both positive and negative experiences in team formulation among students in Institute A. Students with positive experience would rate this item high, and it could be expected those with negative experience would rate this item high too to express their concerns. Indeed, "*I hope I get a better group next time.*" is one of the common responses in Thomsen et al.'s [6] evaluation of SBL.

TABLE III
DIFFERENCES IN RESPONSES BETWEEN THE TWO INSTITUTES

Item	Independent samples *t*-test			
	t	*P*-value (2-tailed)	FDR critical value	FDR Sig.
C1	-0.101	0.920	0.050	Not Sig.
C2	-3.748	0.000	0.004	Sig.
C3	-3.165	0.002	0.008	Sig.
C4	-0.049	0.961	0.054	Not Sig.
L1	-1.944	0.055	0.035	Not Sig.
L2	-1.818	0.074	0.038	Not Sig.
L3	-2.592	0.011	0.015	Not Sig.
L4	-0.941	0.350	0.046	Not Sig.
L5	-2.227	0.029	0.019	Not Sig.
L6	-1.578	0.118	0.042	Not Sig.
L7	-2.753	0.007	0.012	Not Sig.
L8	-2.189	0.032	0.023	Not Sig.
S1	-2.149	0.036	0.027	Not Sig.

IV. CONCLUSIONS

Consistent with previous evaluation studies on the application of simulations and game-based learning in construction management discipline, the students' feedback on the SBL approach in two construction courses from two different institutes are positive. Although the use of scenarios in the two courses was more on provision of a realistic context for completing a reasonably complex group task without using any advanced interactive media, this does not discount its effectiveness in enhancing the students' learning experience. The students from both institutes really appreciated the opportunities to apply concepts learnt in the lectures in their SBL group work. Also, they perceived that the SBL approach is effective in developing their reflective and critical thinking skills, analytic and problem-solving skills and their ability to work as a team. In terms of the characteristics of a favourable SBL environment, they strongly agreed that the formulation of team with right members would enhance their learning experience in SBL. In this, educators who act as facilitators in SBL process play an important role to actively engage with students in order to be able to address students' concern about group membership in a timely manner. The other identified important characteristic is 'constant engagement with lecturer or educator'.

From this survey study, it is plausible to suggest that the majority of the students deemed the SBL approach effective. However, a similar study in future could consider gathering students' feedback via various sources including focus group and interviews that would provide insights into how the SBL approach could be improved to further enhance students' learning experience.

REFERENCE

[1] M. Savin-Baden, "Challenging models and perspectives of problem-based learning", in *Management of change: Implementation of problem-based and project-based learning in engineering,* Eds. E. de Graaff, A. Kolmos, Sense Publishers, pp. 9-30, 2007.

[2] A. Coghlan, "Using Scenario-Based Learning to Teach Tourism Management at the Master's Level", *Journal of Hospitality & Tourism Education*, vol. *27*, no. 1, pp. 1-9, 2015.

[3] N.J. Buch, and T.F. Wolff, "Classroom teaching through inquiry." *Journal of professional issues in engineering education and practice,* vol. 126, no. 3, pp. 105-109, 2000.

[4] R.W. Kindley, "The power of simulation-based e-learning (SIMBEL)", *The eLearning Developers' Journal*, vol. 17, 2002.

[5] S. Agostinho, J. Meek, and J. Herrington, "Design methodology for the implementation and evaluation of a scenario-based online learning environment", *Journal of Interactive Learning Research*, vol. 16, no. 3, pp. 229-242, 2005.

[6] B.C. Thomsen, C.C. Renaud, S.J. Savory, E.J. Romans, O. Mitrofanov, M. Rio, S.E. Day, A.J. Kenyon, and J.E. Mitchell, "Introducing scenario based learning: Experiences from an undergraduate electronic and electrical engineering course", in *Education Engineering (EDUCON), 2010 IEEE*, pp. 953-958, 2010.

[7] K.A. Frost, E.P. Metcalf, R. Brooks, P. Kinnersley, S.R. Greenwood and C.V. Powell, "Teaching pediatric communication skills to medical students", *Advances in medical education and practice*, vol. 6, pp. 35-43, 2015.

[8] A.A. Deshpande and S. H. Huang, "Simulation games in engineering education: A state-of-the-art review", *Computer Applications in Engineering Education*, vol. 19, no. 3, pp. 399-410, 2011.

[9] S. de Freitas, "Learning through play", Internal report, London: Learning and Skills Research Centre, 2004.

[10] S. de Freitas and M. Oliver, "How can exploratory learning with games and simulations within the curriculum be most effectively evaluated?", *Computers & Education*, vol. 46, no. 3, pp. 249-264, 2006.

[11] A. Jaafari, K.K. Manivong and M. Chaaya, "VIRCON: Interactive system for teaching construction management", *Journal of Construction Engineering and Management,* vol. 127, no.1, pp. 66-75, 2001.

[12] J. Wall, and V. Ahmed, "Use of a simulation game in delivering blended lifelong learning in the construction industry – Opportunities and Challenges", *Computers & Education*, vol. 50, no. 4, pp. 1383-1393, 2008.

[13] G. Long, M.J. Mawdesley, and D. Scott, (2009). Teaching construction management through games alone: a detailed investigation. *On the Horizon*, vol. 17, no. 4, 330-344, 2009.

[14] R.J. Dzeng, K.Y. Lin and P.R. Wang, "Building a construction procurement negotiation training game model: Learning experiences and outcomes", *British Journal of Educational Technology*, vol. 45, no. 6, pp. 1115-1135, 2014.

[15] J.H. McDonald, *Handbook of Biological Statistics,* 3rd ed. Baltimore, Maryland: Sparky House Publishing, 2014.

[16] M. Pivec and O. Dziabenko, "Game-based learning in universities and lifelong learning: UniGame: social skills and knowledge training" game concept", *Journal of Universal Computer Science*, vol. 10, no. 1, pp. 14-26, 2004.